IMPORTANT NOTICE

EA 04-013094 11/29/04

This **Fish and Wildlife Service** permit is currently being amended and shall be used as reference only. All information necessary for bidding purpose is contained in the Plan and the Special Provisions. Please note the working window stated in this permit has been changed. Please see the Special Provision for the revised working window.

From Appendix E

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
3310 El Camino Avenue, Suite 130
Sacramento, California 95821-6340

RECEIVED
SEP 04 1997
FHWA

IN REPLY REFER TO
1-1-97-F-116

AD/12-27-02

September 3, 1997

David H. Densmore, Division Administrator
U.S. Department of Transportation
Federal Highway Administration
Region Nine, California Division
980 Ninth Street, Suite 400
Sacramento, California 95814-2724

Subject: Formal Consultation and Conference on the Proposed 1927 Carquinez Bridge Replacement Project and the 1958 Carquinez Bridge Seismic Retrofit Project on Interstate 80 between Vallejo, Solano County and Crockett, Contra Costa County, California (File Number 04-CC-80-13.5/14.1)

Dear Mr. Densmore:

This is in response to your April 28, 1997, request for formal consultation with the U.S. Fish and Wildlife Service (Service) on the proposed Carquinez Bridge Replacement Project and Seismic Retrofit Project on Interstate 80 between Vallejo, Solano County, and Crockett, Contra Costa County, California. Your request was received in our office on April 30, 1997. This document represents the Service's biological and conference opinions on the effects of the actions on the threatened delta smelt (*Hypomesus transpacificus*) and its critical habitat and on the Sacramento splittail (*Pogonichthys macrolepidotus*), a species that has been proposed for Federal listing, in accordance with section 7 of the Endangered Species Act of 1973, as amended.

These biological and conference opinions are based on information provided in: (1) the Preliminary Natural Environment Study and Biological Assessment, Carquinez Bridge Replacement, dated October 1994; (2) the Carquinez Bridge Seismic Upgrade Project Natural Environment Study Addendum, dated September 1996; (3) the Draft Environmental Impact Statement/Statutory Exemption I-80 Carquinez Bridge Project, dated January 1997; (4) several meetings with representatives from the Department of Transportation and the Service; and (5) other sources of information contained in the Service's files. A complete administrative record of this consultation and conference is on file in the Sacramento Fish and Wildlife Office. Please refer to the file number, 1-1-97-F-116, when requesting information concerning these opinions.

Consultation History

On September 20, 1996, Mr. Chuck Morton, District Branch Chief of the Office of Environmental Planning North, California Department of Transportation, informally consulted

with the Service to discuss two options for the Carquinez 1927 Bridge Project: (1) the possibility of seismic retrofitting both bridges to bring them up to current standards, or (2) the possibility of seismic retrofitting the 1958 bridge and replacing the 1927 bridge to allow for facilitated movement of traffic from Vallejo, Solano County, and Crockett, Contra Costa County, California. The purpose of the meeting was to obtain information on how the proposed plans might affect delta smelt, its critical habitat, and Sacramento splittail. Subsequent telephone conversations between Mr. Morton and Service staff followed in order to develop a mitigation plan to offset the impacts of the proposed projects. On April 28, 1997, the Federal Highway Administration initiated formal consultation on the proposed 1927 bridge replacement project. On May 2, 1997, the California Department of Transportation provided a copy of a mitigation proposal (from Philip Williams & Associates, Ltd.) to utilize an area in Alhambra Creek, at the Martinez Regional Shoreline Park, to offset the impacts of the proposed project. The proposed mitigation plan was reviewed by Service staff and on July 7, 1997, the Service approved the plan. Copies of the mitigation plan and accepted modifications are contained within Service files. On approximately July 23, 1997, Mr. Morton requested that the 1958 seismic retrofit project be incorporated into the request for formal consultation on the 1927 bridge replacement project.

BIOLOGICAL AND CONFERENCE OPINIONS

Description of the Proposed Action

The California Department of Transportation (Caltrans), in cooperation with the Federal Highway Administration, proposes to replace the 1927 bridge which carries the westbound lanes of Interstate 80 (I-80) over the Carquinez Strait and seismic retrofit the 1958 bridge which carries the eastbound lanes of I-80 over the Carquinez Strait, in the northeastern San Francisco Bay Area (Figure 1). The two steel truss bridges are often referred to in combination as "the Carquinez Bridge."

The purpose of the Carquinez Bridge Replacement Project is to provide a westbound I-80 crossing of the Carquinez Strait that meets current seismic and traffic safety standards. Since its construction in 1927, the westbound bridge has experienced corrosion of its metal components due to exposure to chemical fumes and salt air. In addition, the intricate and inaccessible structural members make preventive maintenance difficult without major traffic disruptions and delays to the public. The total load-carrying capacity of the bridge has been affected by corrosion damage, at the same time that traffic volumes have increased, increasing the load (*i.e.*, weight) on the bridge.

Both the 1927 and 1958 bridges were recently assessed for structural integrity and vulnerability to damage or failure during a major seismic event and were found to require retrofitting to meet present seismic safety standards. The east bridge, including the east bound on-ramp, is

scheduled to be seismically retrofitted beginning in late 1997. The west bridge also requires substantial improvements, but due to the age, condition, and design of the structure, a replacement alternative was proposed and adopted.

The Carquinez Bridge Project is needed because the existing bridge does not meet current safety standards for either seismic or traffic safety. The project is proposed to address the following six major transportation needs identified specifically at the crossing of the Carquinez Strait between Vallejo and Crockett, and generally in the I-80 corridor: (1) satisfy current seismic standards for transportation facilities and ensure the non-collapse of a critical link in the transportation network in the event of a major seismic event; (2) correct existing roadway deficiencies that do not meet current design standards for interstate facilities; (3) improve traffic safety; (4) maintain an important route over the Strait for freight and goods movement; (5) provide for and encourage the use of alternative modes of transportation, thereby improving the balance of transportation services that are offered in a fast-growing travel corridor; and (6) support high-occupancy vehicle (HOV) use.

1927 Replacement Bridge

The replacement of the 1927 bridge will be constructed to the west of the existing bridges and will lie about 51 meters (168 feet) on center to the existing 1927 bridge (Figure 2). The bridge will be about 25 meters (82 feet) wide, and will provide four 3.6 meter (12-foot) wide traffic lanes, two standard 3.0 meter (10-foot) wide shoulders, and a 3.6 meter wide pedestrian and bicycle lane with a 0.6 meter (2-foot) wide barrier separating this lane from vehicular traffic. The new north approach roadway will require relocation of the existing Caltrans maintenance station, but will clear the existing PG&E towers. The new suspension bridge towers and foundation will line up with the towers of the existing bridges on the south end, but will be located closer to the shoreline and out of the main channel on the north end. There will be no center pier for the suspension bridge which will limit impacts to aquatic habitat.

Following construction of the replacement bridge, westbound traffic will be relocated from the exiting 1927 bridge onto the new bridge, and the 1927 bridge will be demolished and removed The foundations and center pier fender system will be retained because they provide some protection to the 1958 (east bound) bridge. Removal of the 1927 bridge will take approximately six months and will be completed as part of the overall construction project, rather than as a separate, later project. Construction of the proposed suspension bridge will impact approximately 0.26 acre of shallow water habitat believed to support the threatened delta smelt. A conceptual mitigation plan has been sent to the Service for review and approval, and consists of the creation of 0.78 acre of shallow water habitat at Alhambra Creek in Martinez to offset these impacts.

1958 Seismic Retrofit

The 1958 bridge carries four lanes of eastbound traffic over the Carquinez Strait. Retrofitting this bridge will take approximately 18 months, and will include improvements to the main span,

the eastbound approach structure to the south, the eastbound off-ramp to Crockett, and the eastbound on-ramp from Crockett.

The retrofit strategy would strengthen superstructure steel truss and towers members, replace truss bearings and deck expansion joints, move the main span abutment backwalls, strengthen the connections between tower legs and foundations, increase pile foundations capacities as needed, and provide confinement for the concrete pier shafts. The design emphasizes strengthening of existing members by increasing member and system ductility, adding some new members but not substantially altering the appearance of the bridge. Foundation strengthening is required at Piers 4 and 5, which are located in Carquinez Strait. Work at Pier 5, which lies within the tidal zone on the south shore, would be accomplished by sheetpile installation, dewatering, and a temporary trestle. Work at Pier 4, which lies immediately to the north of Pier 5, would be accomplished from a barge or trestle and would include modifications to the related fender system. As a result of the retrofit construction, Pier 4 would impact 200 square feet of delta smelt critical habitat and Pier 5 would would impact 5,984 square feet of delta smelt critical habitat. Subsequently, the 1958 seismic retrofit project would impact approximately 0.14 acre of shallow water habitat believed to support the threatened delta smelt. The mitigation required to offset these impacts will consist of the creation of 0.42 acre of shallow water habitat and will be tied into the conceptual mitigation plan at the Alhambra Creek site in Martinez. A total of 1.20 acres of shallow water habitat will be created at the Alhambra Creek site to mitigate the impact of both projects.

Status of the Species

Delta smelt

The delta smelt was listed as a threatened species on March 5, 1993, (58 FR 12854). The delta smelt is a slender-bodied fish with a steely blue sheen on the sides and seems almost translucent (Moyle 1976). The delta smelt, which has a lifespan of one year, has an average length of 60 to 70 mm (about 2 to 3 inches) and is endemic to Suisun Bay upstream of San Francisco Bay through the Delta in Contra Costa, Sacramento, San Joaquin, and Solano counties, California.

Historically, the delta smelt is thought to have occurred from Suisun Bay upstream to at least the city of Sacramento on the Sacramento River and Mossdale on the San Joaquin River (Moyle *et al.* 1992, Sweetnam and Stevens 1993). The delta smelt is a euryhaline species (tolerant of a wide salinity range) that spawns in fresh water and has been collected from estuarine waters up to 14 parts per thousand (ppt) salinity (Moyle *et al.* 1992). For a large part of its annual life span, this species is associated with the freshwater edge of the mixing zone (saltwater-freshwater interface, also called X2), where the salinity is approximately 2 ppt (Ganssle 1966, Moyle *et al.* 1992, Sweetnam and Stevens 1993).

The delta smelt is adapted to living in the highly productive San Francisco Bay/Delta Estuary where salinity varies spatially and temporally according to tidal cycles and the amount of

freshwater inflow. Despite this tremendously variable environment, the historic Estuary probably offered relatively constant suitable habitat conditions for delta smelt, because they could move upstream or downstream with the mixing zone (Moyle, pers. comm., 1993). The final rule to list the delta smelt as threatened (58 FR 12854) describes in detail the factors that have contributed to this species' decline.

Shortly before spawning, adult delta smelt migrate upstream from the brackish-water habitat associated with the mixing zone to disperse widely into river channels and tidally-influenced backwater sloughs (Radtke 1966, Moyle 1976, Wang 1991). Migrating adults with nearly mature eggs were taken at the Central Valley Project (CVP) Tracy Pumping Plant from late December 1990 to April 1991 (Wang 1991). Spawning locations appear to vary widely from year to year (Department and Reclamation 1993). Sampling of larval delta smelt in the Delta suggests spawning has occurred in the Sacramento River; Barker, Lindsey, Cache, Georgiana, Prospect, Beaver, Hog, and Sycamore sloughs; in the San Joaquin River off Bradford Island including Fisherman's Cut; False River along the shore zone between Frank's and Webb tracts; and possibly other areas (Dale Sweetnam, Fish and Game, pers. comm., Wang 1991). Delta smelt also may spawn north of Suisun Bay in Montezuma and Suisun sloughs and their tributaries (Sweetnam, Fish and Game, pers. comm.).

Delta smelt spawn in shallow, fresh, or slightly brackish water upstream of the mixing zone (Wang 1991). Most spawning occurs in tidally-influenced backwater sloughs and channel edgewaters (Moyle 1976, Wang 1986, 1991, Moyle *et al.* 1992). Although delta smelt spawning behavior has not been observed in the wild (Moyle *et al.* 1992), the adhesive, demersal eggs are thought to attach to substrates such as cattails, tules, tree roots, and submerged branches (Moyle 1976, Wang 1991).

The spawning season varies from year to year and may occur from late winter (December) to early summer (July). Moyle (1976) collected gravid adults from December to April, although ripe delta smelt were most common in February and March. In 1989 and 1990, Wang (1991) estimated that spawning had taken place from mid-February to late June or early July, with peak spawning occurring in late April and early May. A recent study of delta smelt eggs and larvae (Wang and Brown 1994 as cited in Department and Reclamation 1994) confirmed that spawning may occur from February through June, with a peak in April and May. Spawning has been reported to occur at about 7° to 15° C. Results from a University of California at Davis (UCD) study (Swanson and Cech 1995) indicate that although delta smelt tolerate a wide range of temperatures (<8° C to >25° C), warmer water temperatures restrict their distribution more than colder water temperatures.

Laboratory observations indicate that delta smelt are broadcast spawners that spawn in a current, usually at night, distributing their eggs over a local area (Lindberg 1992 and Mager 1993 as cited in Department and Reclamation 1994). The eggs form an adhesive foot that appears to stick to most surfaces. In these laboratory studies, the eggs attached singly to the substrate, with few eggs found on vertical plants or the sides of a culture tank (Lindberg 1993 as cited in Department and Reclamation 1994).

Delta smelt eggs hatched in 9 to 14 days at temperatures from 13° to 16° C during laboratory observations in 1992 (Mager 1992 as cited in Sweetnam and Stevens 1993). In this study, larvae began feeding on phytoplankton on day four, rotifers on day six, and *Artemia nauplii* at day 14. In laboratory studies, yolk-sac fry were found to be positively phototaxic, swimming to the lightest corner of the incubator, and negatively buoyant, actively swimming to the surface. The post-yolk-sac fry were more evenly distributed throughout the water column (Lindberg 1992 as cited in Department and Reclamation 1994). After hatching, larvae and juveniles move downstream toward the mixing zone where they are retained by the vertical circulation of fresh and salt waters (Stevens *et al.* 1990). The pelagic larvae and juveniles feed on zooplankton. When the mixing zone is located in Suisun Bay where there is extensive shallow-water habitat within the euphotic zone (depths less than four meters), high densities of phytoplankton and zooplankton may accumulate (Arthur and Ball 1978, 1979, 1980). In general, estuaries are among the most productive ecosystems in the world (Goldman and Horne 1993). Estuarine environments produce an abundance of fish and zooplankton as a result of plentiful food and shallow, productive habitat.

Delta smelt swimming behavior. Observations of delta smelt swimming in the swimming flume and in a large tank show that these fish are unsteady, intermittent, slow-speed swimmers (Swanson and Cech 1995). At low velocities in the swimming flume (<3 body lengths per second), and during spontaneous, unrestricted swimming in a 1-meter tank, delta smelt consistently swam with a "stroke and glide" behavior. This type of swimming is very efficient; Weihs (1974) predicted energy savings of about 50 percent for "stroke and glide" swimming compared to steady swimming. However, the maximum speed delta smelt are able to achieve using this preferred mode of swimming, or gait, is less than 3 body lengths per second, and the fish did not readily or spontaneously swim at this or higher speeds (Swanson and Cech 1995). Juvenile delta smelt proved stronger swimmers than adults. Forced swimming at these speeds in a swimming flume was apparently stressful; the fish were prone to swimming failure and extremely vulnerable to impingement. Unlike fish for which this type of measurements have been made in the past, delta smelt swimming performance was limited by behavioral rather than physiological or metabolic constraints *(e.g.*, metabolic scope for activity; Brett 1976). Please refer to final rules 58 **FR** 12854 and 59 **FR** 65255 and Department and Reclamation (1994) for additional information on the biology and ecology of the delta smelt.

Delta Smelt Critical Habitat

In determining which areas to designate as critical habitat, the Service considers those physical and biological features that are essential to a species' conservation and that may require special management considerations or protection (50 CFR §424.12(b)).

The Service is required to list the known primary constituent elements together with the critical habitat description. Such physical and biological features include, but are not limited to, the following:

(1) space for individual and population growth, and for normal behavior;

(2) food, water, air, light, minerals, or other nutritional or physiological requirements;

(3) cover or shelter;

(4) sites for breeding, reproduction, rearing of offspring, germination, or seed dispersal; and

(5) generally, habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of a species.

In designating critical habitat for the delta smelt, the Service identified the following primary constituent elements essential to the conservation of the species: physical habitat, water, river flow, and salinity concentrations required to maintain delta smelt habitat for spawning, larval and juvenile transport, rearing, and adult migration. Critical habitat for delta smelt was originally proposed in the lower Sacramento-San Joaquin Delta and Suisun and Honker bays. However, after considerable debate, critical habitat was reproposed and is now contained within Contra Costa, Sacramento, San Joaquin, Solano, and Yolo counties.

Spawning habitat. Specific areas that have been identified as important delta smelt spawning habitat include Barker, Lindsey, Cache, Prospect, Georgiana, Beaver, Hog, and Sycamore sloughs and the Sacramento River in the Delta, and tributaries of northern Suisun Bay.

Larval and juvenile transport. Adequate river flow is necessary to transport larvae from upstream spawning areas to rearing habitat in Suisun Bay and to ensure that rearing habitat is maintained in Suisun Bay. To ensure this, X2 must be located westward of the confluence of the Sacramento-San Joaquin Rivers, located near Collinsville (Confluence), during the period when larvae or juveniles are being transported, according to historical salinity conditions. X2 is important because the "entrapment zone" or zone where particles, nutrients, and plankton are "trapped," leading to an area of high productivity, is associated with its location. Habitat conditions suitable for transport of larvae and juveniles may be needed by the species as early as February 1 and as late as August 31, because the spawning season varies from year to year and may start as early as December and extend until July.

Rearing habitat. An area extending eastward from Carquinez Strait, including Suisun, Grizzly, and Honker bays, Montezuma Slough and its tributary sloughs, up the Sacramento River to its confluence with Three Mile Slough, and south along the San Joaquin River including Big Break, defines the specific geographic area critical to the maintenance of suitable rearing habitat. Three Mile Slough represents the approximate location of the most upstream extent of historical tidal incursion. Rearing habitat is vulnerable to impacts of export pumping and salinity intrusion from the beginning of February to the end of August.

Adult migration. Adequate flow and suitable water quality are needed to attract migrating adults in the Sacramento and San Joaquin river channels and their associated tributaries, including

Cache and Montezuma sloughs and their tributaries. These areas are vulnerable to physical disturbance and flow disruption during migratory periods.

The Service's 1994 and 1995 biological opinions provided for adequate larval and juvenile transport flows, rearing habitat, and protection from entrainment for upstream migrating adults (Service 1994a, 1995). Please refer to 59 **FR** 65255 for additional information on delta smelt critical habitat.

Sacramento Splittail

The Sacramento splittail is a large cyprinid that can reach greater than 12 inches in length (Moyle 1976). Adults are characterized by an elongated body, distinct nuchal hump, and a small blunt head with barbels usually present at the corners of the slightly subterminal mouth. This species can be distinguished from other minnows in the Central Valley of California by the enlarged dorsal lobe of the caudal fin. Sacramento splittail are a dull, silvery-gold on the sides and olive-grey dorsally. During the spawning season, the pectoral, pelvic and caudal fins are tinged with an orange-red color. Males develop small white nuptial tubercles on the head.

Sacramento splittail are endemic to California's Central Valley where they were once widely distributed in lakes and rivers (Moyle 1976). Historically, Sacramento splittail were found as far north as Redding on the Sacramento River and as far south as the site of Friant Dam on the San Joaquin River (Rutter 1908). Rutter (1908) also found Sacramento splittail as far upstream as the current Oroville Dam site on the Feather River and Folsom Dam site on the American River. Anglers in Sacramento reported catches of 50 or more Sacramento splittail per day prior to damming of these rivers (Caywood 1974). Sacramento splittail were common in San Pablo Bay and Carquinez Strait following high winter flows until about 1985 (Messersmith 1966, Moyle 1976, and Wang 1986 as cited in Department and Reclamation 1994).

In recent times, dams and diversions have increasingly prevented upstream access to large rivers and the species is restricted to a small portion of its former range (Moyle and Yoshiyama 1992). Sacramento splittail enter the lower reaches of the Feather and American rivers (Charles Hanson, State Water Contractors, *in litt.*, 1993) on occasion, but the species is now largely confined to the Delta, Suisun Bay, and Suisun Marsh (Service 1994a). Stream surveys in the San Joaquin Valley reported observations of Sacramento splittail in the San Joaquin River below the mouth of the Merced River and upstream of the confluence of the Tuolumne River (Saiki 1984 as cited in Department and Reclamation 1994).

Sacramento splittail are long-lived, frequently reaching five to seven years of age. Generally, females are highly fecund, producing over 100,000 eggs each year (Daniels and Moyle 1983) Populations fluctuate annually depending on spawning success, which is highly correlated with freshwater outflow and the availability of shallow-water habitat with submersed, aquatic vegetation (Daniels and Moyle 1983). Sacramento splittail usually reach sexual maturity by the end of their second year at a size of 180 to 200 mm. There is some variability in the reproductive period since older fish reproduce before younger individuals (Caywood 1974)

The largest recorded Sacramento splittail has measured between 380 and 400 mm (Caywood 1974, Daniels and Moyle 1983). Adults migrate into fresh water in late fall and early winter prior to spawning. The onset of spawning is associated with rising temperature, lengthening photoperiod, seasonal runoff, and possibly endogenous factors from the months of March through May, although there are records of spawning from late January to early July (Wang 1986). Spawning occurs in water temperatures from 9° to 20° C over flooded vegetation in tidal freshwater and euryhaline habitats of estuarine marshes and sloughs and slow-moving reaches of large rivers. The eggs are adhesive or become adhesive soon after contacting water (Caywood 1974, and Bailey, University of California at Davis, pers. comm. 1994 as cited in Department and Reclamation 1994). Larvae remain in shallow, weedy areas close to spawning sites and move into deeper water as they mature (Wang 1986).

Sacramento splittail are benthic foragers that feed on opossum shrimp, although detrital material makes up a large percentage of their stomach contents (Daniels and Moyle 1983). Earthworms, clams, insect larvae, and other invertebrates are also found in the diet. Predators include striped bass and other piscivorous fish, birds, and mammals. Sacramento splittail are sometimes used as bait by anglers for striped bass.

Sacramento splittail can tolerate salinities as high as 10 to 18 ppt (Moyle 1976, Moyle and Yoshiyama 1992). Sacramento splittail are found throughout the Delta (Turner and Kelly 1966), Suisun Bay, and Suisun and Napa marshes. They migrate upstream from brackish areas to spawn in freshwater. Because they require flooded vegetation for spawning and rearing, Sacramento splittail are frequently found in areas subject to flooding.

The 1985 to 1992 decline in Sacramento splittail abundance is concurrent with hydrologic changes to the Estuary. These changes include increases in water diversions during the spawning period from January through July. Diversions, dams and reduced outflow, coupled with severe drought years, introduced aquatic species, and loss of wetlands and shallow-water habitat have reduced the species' capacity to reverse its decline (Moyle *et. al.* 1992). Please refer to 59 **FR** 862 and Department and Reclamation (1994) for additional information on the biology and ecology of the Sacramento splittail.

Environmental Baseline

Delta smelt

Adult delta smelt spawn in central Delta sloughs from February through August in shallow water areas having submersed aquatic plants and other suitable substrates and refugia. These shallow water areas have been identified in the Delta Native Fishes Recovery Plan (Recovery Plan) (Service 1996a) as essential to the long-term survival and recovery of delta smelt and other resident fish. A no net loss strategy of delta smelt population and habitat is proposed in this Recovery Plan.

The delta smelt is adapted to living in the highly productive Estuary where salinity varies spatially and temporally according to tidal cycles and the amount of freshwater inflow. Despite this tremendously variable environment, the historical Estuary probably offered relatively consistent spring transport flows that moved delta smelt juveniles and larvae downstream to the mixing zone (Peter Moyle, UCD, pers. comm.). Since the 1850's, however, the amount and extent of suitable habitat for the delta smelt has declined dramatically. The advent in 1853 of hydraulic mining in the Sacramento and San Joaquin rivers led to increased siltation and alteration of the circulation patterns of the Estuary (Nichols *et al.* 1986, Monroe and Kelly 1992). The reclamation of Merritt Island for agricultural purposes, in the same year, marked the beginning of the present-day cumulative loss of 94 percent of the Estuary's tidal marshes (Nichols *et al.* 1986, Monroe and Kelly 1992).

In addition to the degradation and loss of estuarine habitat, the delta smelt has been increasingly subject to entrainment, upstream or reverse flows of waters in the Delta and San Joaquin River, and constriction of low salinity habitat to deep-water river channels of the interior Delta (Moyle *et al.* 1992). These adverse conditions are primarily a result of drought and the steadily increasing proportion of river flow being diverted from the Delta by the CVP and SWP (Monroe and Kelly 1992). The relationship between the portion of the delta smelt population west of the Delta and the natural logarithm of Delta outflow from 1959 to 1988 has been sampled in the summer townet survey (Department and Reclamation 1994). This relationship indicates that the summer townet index increased dramatically when outflow was between 34,000 and 48,000 cfs which placed X2 between Chipps and Roe islands. Placement of X2 downstream of the Confluence, Chipps and Roe islands provides delta smelt with low salinity and protection from entrainment, allowing for productive rearing habitat that increases both smelt abundance and distribution.

The results of seven surveys conducted by the Interagency Ecological Program (IEP) corroborate the dramatic decline in delta smelt attributable to baseline conditions. Existing baseline conditions provide sufficient Delta outflows from February 1 through June 30 to transport larval and juvenile delta smelt out of the "zone of influence" of the CVP and SWP pumps, and provide them low salinity, productive rearing habitat. This zone of influence has been delineated by Water Resources's Particle Tracking Model and expands or contracts with CVP and SWP combined pumping increases or decreases, respectively (Department and Reclamation 1993). With the effects of tidal movement contributing additional movement, the influence of the pumps may entrain larvae and juveniles as far west as the Confluence.

According to seven abundance indices designed to record trends in the status of the delta smelt, this species was consistently at low population levels during the last ten years (Stevens *et al.* 1990). These same indices also show a pronounced decline from historical levels of abundance (Stevens *et al.* 1990). The summer townet abundance index constitutes one of the more representative indices because the data have been collected over a wide geographic area (from San Pablo Bay upstream through most of the Delta) for the longest period of time (since 1959). The summer townet abundance index measures the abundance and distribution of juvenile delta smelt and provides data on the recruitment potential of the species. Except for three years since

1983 (1986, 1993, and 1994), this index has remained at consistently lower levels than experienced previously. As indicated previously, these consistently lower levels correlate with the 1983 to 1992 mean location of X2 upstream of the Confluence, Chipps and Roe islands. The second longest running survey (since 1967), the fall midwater trawl survey (FMWT), measures the abundance and distribution of late juveniles and adult delta smelt in a large geographic area from San Pablo Bay upstream to Rio Vista on the Sacramento River and Stockton on the San Joaquin River (Stevens *et al.* 1990). The fall midwater trawl provides an indication of the abundance of the adult population just prior to upstream spawning migration. The index that is calculated from the FMWT survey uses numbers of sampled fish multiplied by a factor related to the volume of the area sampled. Until recently, except for 1991, this index has declined irregularly over the past 20 years. Since 1983, the delta smelt population has exhibited more low fall midwater trawl abundance indices, for more consecutive years, than previously recorded. The 1994 FMWT index of 101.7 is a continuation of this trend. This occurred despite the high 1994 summer townet index for unknown reasons. (The 1995 summer townet was a low index value of 319 but resulted in a high FMWT index of 898.7 reflecting the benefits of large transport and habitat maintenance flows with the Bay-Delta Accord in place and a wet year).

The current abundance index for 1996 reports the fourth lowest on record indicating that the species may be moving towards extinction.

Delta Smelt Critical Habitat

Delta smelt critical habitat has been affected by activities that destroy spawning and refugial areas and change hydrology patterns in Delta waterways. Critical habitat also has been affected by diversions that have shifted the position of X2 upstream of the confluence of the Sacramento and San Joaquin rivers. This shift has caused a decreased abundance of delta smelt. Existing baseline conditions and implementation of the Service's 1994 and 1995 biological opinions concerning the operation of the CVP and SWP, provide a substantial part of the necessary positive riverine flows and estuarine outflows to transport delta smelt larvae downstream to suitable rearing habitat in Suisun Bay outside the influence of marinas, agricultural diversions, and Federal and State pumping plants.

Bay-Delta Accord changes to the environmental baseline. The December 14, 1994, signing of the Bay-Delta Accord provided significant beneficial actions to the Delta.

On December 23, 1994, the CVP and SWP began operations in accordance with the Bay-Delta Accord, the delta smelt and winter-run chinook biological opinions for the operations of the CVP and SWP, and the delta smelt biological opinion on the Environmental Protection Agency's Water Quality Standards for the San Francisco/Sacramento-San Joaquin Rivers and Delta (Service 1994a, 1994b, 1995, NMFS 1993, 1995). The water quality standards and operational constraints contained within these documents provide biological benefits in the form of: (1) Delta outflow, (2) X2 protection measures, (3) San Joaquin River protection measures, (4) Delta Cross Channel Gate Closure, (5) combined export rate limits, (6) daily export rate limits, (7) operational flexibility, and (8) protections for brackish tidal marshes of Suisun Bay.

Other operational changes made to benefit delta smelt, delta smelt critical habitat, and the proposed Sacramento splittail include maintenance of (1) low electrical conductivity at Collinsville, (2) 30 day pulse flows down the San Joaquin River between April 15 and May 30, (3) a San Joaquin River accedence forecast to determine required San Joaquin River flows, and (4) monitoring at the North Bay Aqueduct at Baker Slough and Prospect Island to provide baseline information and reduce entrainment.

Consideration of any future biological opinions based on new or reinitiated consultations will recognize three major initiatives that shape the dynamics of future estuarine conditions for delta smelt. First, are the water quality standards that were finalized in 1995, in accordance with a 1994 Framework Agreement between the Governor's Water Policy Council of the State of California (Council) and the Service, NMFS, EPA, Reclamation (collectively known as "Club Fed"), and the State Water Resources Control Board (SWRCB)? In addition, water right proceedings are under way to allocate responsibility among water right holders in the Bay-Delta watershed. Second, section 7(a)(1) of the Act imposes an affirmative obligation on Federal agencies to carry out programs for the conservation (recovery) of listed species. With the November 26, 1996, Delta Native Fishes Recovery Plan (Service 1996a), the Service expects that participating and affected local, State, and Federal agencies will fulfill their responsibilities by assisting in the completion of tasks and objectives mentioned in the Recovery Plan. Third, and related to number two above, the scheduled renewal or reopening of water contracts and licenses (such as, reopened or expired Federal Energy Regulatory Commission (FERC) licenses, expired CVP water contracts) will provide an additional opportunity under section 7(a)(1) and 7(a)(2) of the Act to implement Recovery Plan objectives and meet EPA's or SWRCB's water quality standards. Collectively, these initiatives will result in a phased improvement to habitat requirements for the delta smelt and Sacramento splittail. Accordingly, the Service anticipates that adverse modification or destruction of critical habitat will be avoided by the CVP and SWP through implementation of the above described initiatives.

Additionally, the Central Valley Project Improvement Act (CVPIA) is providing beneficial actions in the Delta. Part of these actions consist of management of 800 thousand acre feet (TAF) of CVP Yield under the CVPIA. To date, management of the 800 TAF of CVP Yield under the CVPIA consists of the following:

(1) springtime pulse flows in the Stanislaus River, and in the lower San Joaquin River;

(2) springtime restrictions on Delta pumping and closure of the Delta Cross Channel gates;

(3) spawning and rearing flow improvements in the mainstem Sacramento, lower American, and Stanislaus rivers in fall and early winter; and

(4) carryover storage of a portion of the dedicated yield in New Melones Reservoir as a contingency against future drought-induced reductions.

Sacramento Splittail

The Sacramento splittail declined over the past 10 years, according to the fall midwater trawl data. This decline was further illustrated using eight surveys done by IEP. This decline is due to hydrologic changes in the Estuary and loss of shallow water habitat due to dredging and filling (Monroe and Kelly, 1992). These changes include increases in water diversions during the spawning period of January through July. Most of the factors that caused delta smelt to decline have also caused the decline of this species. Diversions, dams and reduced outflow, coupled with severe drought years, introduced aquatic species such as the Asiatic clam (Nichols *et al.* 1986), and loss of wetlands and shallow-water habitat apparently have perpetuated the species' decline.

Effects of the Proposed Action

Delta Smelt and Sacramento Splittail

As stated in the *Description of the Proposed Action* section above, the replacement of the 1927 bridge and the seismic retrofit of the 1958 bridge will impact 0.40 acre of shallow water habitat in the Carquinez Strait area. Because the applicant has proposed to offset these impacts at a 3:1 ratio at Alhambra Creek in Martinez, the impacts to shallow water habitat from the proposed project will be minor. The mitigation site will be designed to increase open water and tidally influenced areas, and provide limited shade, shelter, and rearing habitat for delta smelt and Sacramento splittail. Moreover, the area will likely attract food items upon which these species depend. The timing of the proposed construction activities may result in direct take of delta smelt and Sacramento splittail utilizing the area. This take may be in the form of harass or kill as construction of the bridge footing in shallow water occurs. Delta smelt and Sacramento splittail may be in the area of the proposed project as early as June 30, and may potentially linger in the area until early January. As January comes to an end, the likelihood of delta smelt and Sacramento splittail remaining in the area is greatly reduced as up-stream spawning migration continues. Subsequently, a work "window" of allowable in-water construction (in areas of 3 meters or less) has been developed for this area includes the period between **December 1 through March 31**.

Critical Habitat

The Service has identified a list of activities that, depending on the season of construction and scale of the project, may result in the destruction or adverse modification of critical habitat (Federal Register Volume 59, Number 4, January 6, 1994). Levee maintenance, dredging and bank-protection activities have been specifically identified as activities likely to result in modification of delta smelt critical habitat. The proposed project will result in about 0.40 acre of impacts from construction of the bridge footings. However, because the applicant has proposed to create a total of 1.20 acres of delta smelt and Sacramento splittail habitat, the proposed action will not appreciably diminish the value of the delta smelt's constituent elements essential to its conservation. This, in turn, will not adversely modify designated critical habitat.

Cumulative Effects

Cumulative effects include the effects of future State, Tribal, local or private actions that are reasonably certain to occur in the action area considered in these biological and conference opinions. Future Federal actions that are unrelated to this proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

Cumulative effects on delta smelt, its proposed critical habitat or Sacramento splittail also include any continuing or future non-Federal diversions of water that may entrain adult or larval fish or that may decrease outflows incrementally, thus shifting upstream the position of the delta smelt's preferred habitat. Water diversions through intakes serving numerous small, private agricultural lands and duck clubs in the Delta, upstream of the Delta, and in Suisun Bay contribute to these cumulative effects. These diversions also include municipal and industrial uses, as well as providing water for power plants. State or local levee maintenance and channel dredging activities also destroy or adversely modify critical habitat by disturbing spawning or rearing habitat. Delta smelt adults seek shallow, tidally-influenced, fresh water (*i.e.*, less than 2 ppt salinity) backwater sloughs and edgewaters for spawning. To assure egg hatching and larval viability, spawning areas also must provide suitable water quality (*i.e.*, low concentrations of contaminants) and substrates for egg attachment (*e.g.*, submersed tree roots, branches, emersed vegetation). Suitable water quality must be provided by addressing point sources of contaminants so that maturation is not impaired by pollutant concentrations. Levee maintenance disturbs spawning and rearing habitat, and re-suspends contaminants into these waters. Additional cumulative effects result from the impacts of point and non-point source chemical contaminant discharges. These contaminants include selenium and numerous pesticides and herbicides associated with discharges related to agricultural and urban activities. Implicated as potential sources of mortality for delta smelt and Sacramento splittail, these contaminants may adversely affect delta smelt and Sacramento splittail reproductive success and survival rates. Spawning habitat may also be affected if submersed aquatic plants used as substrates for adhesive egg attachment are lost due to toxic substances.

Conclusion

Construction of the new suspension bridge across Carquinez Strait and the seismic retrofit of the 1958 bridge will have a minor impact on delta smelt critical habitat, and the proposed mitigation site will offset the impacts to shallow water habitat for the delta smelt and Sacramento splittail. This area will in-turn provide shallow water rearing habitat in the area of Carquinez Strait. After reviewing the current status of the delta smelt, the environmental baseline for the action area, and the cumulative effects, it is the Service's biological opinion that the proposed Carquinez Bridge Replacement Project is not likely to jeopardize the continued existence of the delta smelt and is not likely to destroy or adversely modify designated critical habitat. After reviewing the current status of the Sacramento splittail, the environmental baseline for the action area, and the cumulative effects, it is the Service's conference opinion that the proposed Carquinez Bridge Replacement Project is not likely to jeopardize the continued existence of the Sacramento splittail.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without a special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct. Harass is defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to a listed species by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Harm is defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by impairing behavioral patterns including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with this Incidental Take Statement.

The measures described below are non-discretionary, and must be implemented by the Federal Highway Administration so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, in order for the exemption in 7(o)(2) to apply. The Federal Highway Administration has a continuing duty to regulate the activity covered by this incidental take statement. If the Federal Highway Administration (1) fails to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, and/or (2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of 7(o)(2) may lapse.

Amount or Extent of Take

The Service anticipates that an unquantifiable number of delta smelt and Sacramento splittail could be taken as a result of this proposed action. The incidental take is expected to be in the form of harassment and kill. The incidental take will be difficult to detect for the following reasons: the small size of delta smelt and Sacramento splittail eggs and larvae, and the unlikelihood of finding dead or impaired specimens. However, take of these species can be anticipated by the impacts to 0.40 acre of shallow water habitat.

Effect of the Take

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the delta smelt or destruction or adverse modification of critical habitat. Similarly, the Service determined that this level of anticipated take is not likely to result in jeopardy to the Sacramento splittail.

Reasonable and Prudent Measures

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize the impact of incidental take on the delta smelt.

(1) The potential for harassment or kill for delta smelt and Sacramento splittail shall be minimized.

(2) Minimize the impacts to shallow water habitat.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, the Federal Highway Administration must ensure compliance with the following terms and conditions, which implement the reasonable and prudent measures described above. These terms and conditions are non-discretionary.

(1) To minimize harassment or kill for delta smelt and Sacramento splittail, all in-water work in areas of 3 meters (9 feet) or less shall be confined to the following work window: **December 1 through March 31**.

(2) To minimize the impacts to shallow water habitat, the proposed creation of 1.20 acres of shallow water habitat at Alhambra Creek shall be constructed prior to, or concurrent with, the proposed bridge replacement and seismic retrofit projects.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize incidental take that might otherwise result from the proposed action. With implementation of these measures, the Service believes that no individuals of delta smelt or Sacramento splittail will be incidentally taken. If, during the course of the action, this minimized level of incidental take is exceeded, such incidental take would represent new information requiring review of the reasonable and prudent measures provided. The Federal agency must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.

Reporting Requirements

Delta Smelt

The Federal Highway Administration shall require Caltrans to report immediately any information about take or suspected take of the delta smelt. The applicant shall immediately notify the Service within one working day of any such information. Notification must include the date, time, and precise location of the incident/specimen and any other pertinent information. The Service contact shall be the Service's Sacramento Fish and Wildlife Office's Endangered Species Division at (916) 979-2725. Any salvaged specimens that have been taken shall be

properly preserved in accordance with the Natural History Museum of Los Angeles County's policy of accessioning (10% formalin in a quart jar or freezing). Information concerning how the fish were taken, length of the interval between death and preservation, the water temperature and outflow/tide conditions, and any other relevant information shall be written on 100% rag content paper and included in the container with the specimen. Preserved specimens shall be delivered to the Service's Division of Law Enforcement at 3310 El Camino, Ste. 140, Sacramento, California 95821-6340 phone (916) 979-2987.

Sacramento Splittail

Same as for the delta smelt, as stipulated above.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species and the ecosystems upon which they depend. The term "conservation recommendation" has been defined as suggestions and are discretionary agency activities that can be implemented to further the purposes of the Act, such as preservation of endangered species habitat, implementation of recovery actions, or development of information and data bases.

(1) The Service recommends that the Federal Highway Administration and Caltrans enhance and restore aquatic and wetland habitat in the Suisun Bay to increase habitat for Delta native fishes.

(2) The Service recommends that the Federal Highway Administration increase public awareness of the importance of Delta native fishes and their habitats.

(3) The Service recommends that the Federal Highway Administration develop a delta smelt mitigation bank to offset the impacts of future projects.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

REINITIATION - CLOSING STATEMENT

The incidental take statement provided with this conference opinion does not become effective for the Sacramento splittail until the species is listed and the conference opinion is adopted as the biological opinion issued through formal consultation. At that time, the project will be reviewed to determine whether any take of the Sacramento splittail has occurred. Modifications of the opinion and the incidental take statement may be appropriate to reflect that take. No take of the Sacramento splittail may occur between the listing of the Sacramento splittail and the adoption of the conference opinion through formal consultation, or the completion of a subsequent formal consultation.

You may ask the Service to adopt the conference opinion incorporated in this consultation as a biological opinion issued through formal consultation, if the Sacramento splittail is listed. The request must be in writing. If the Service reviews the proposed action and finds that there have been no significant changes in the action as planned, or in the information used during the conference, the Service will adopt the conference opinion as the biological opinion on the project.

This concludes formal consultation and conference on the proposed Carquinez Bridge Replacement Project. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been maintained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveal effects of the proposed action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in this opinion; or (4) a new species or critical habitat is designated that may be affected by the proposed action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation. Please contact Mr. Matthew D. Vandenberg of this office at (916) 979-2752, if you have any questions.

Sincerely,

for Wayne S. White
Field Supervisor

cc: AES, Portland, OR
Dale Sweetnam, CDFG, Stockton, CA
Pat Brantley, CDFG, Stockton, CA

LITERATURE CITED

Arthur, J.F. and M.D. Ball 1980. The significance of the entrapment zone location to the phytoplankton standing crop in the San Francisco Bay-Delta Estuary. U.S. Dept. Interior, Water and Power Resources Service.

Arthur, J.F. and M.D. Ball 1979. Factors influencing the entrapment of suspended material in the San Francisco Bay-Delta Estuary. Pages 143-174 *in* T.J. Conomos, editor. Pacific Division, Amer. Assoc. Advance. Sci., San Francisco, California.

Arthur, J.F. and M.D. Ball 1978. Entrapment of suspended materials in the San Francisco Bay-Delta Estuary. U.S. Dept. Interior, Bureau of Reclamation, Sacramento, California.

Brett, J.R. 1976. Scope for metabolism and growth of sockeye salmon, *Oncorhynchus nerka*, and some related energetics. J. Fish. Res. Bd. Can. 33.307-313.

California Department of Fish and Game 1992. Draft five year status report. CDFG, Inland Fish. Div.

Caywood, M.L. 1974. Contributions to the Life History of the Splittail *Pogonichthys macrolepidotus* (Ayres). M.S. Thesis, California State U., Sacramento. 77 pp.

Daniels, R.A. and P.B. Moyle 1983. Life history of splittail (Cyprinidae: *Pogonichthys macrolepidotus*) in the Sacramento-San Joaquin estuary. Fishery Bulletin 84-3:647-654.

Department of Water Resources and U.S. Bureau of Reclamation, Mid-Pacific Region 1993. Effects of the Central Valley Project and State Water Project on delta smelt. 134 pp.

Ganssle, D. 1966. Fishes and decapods of San Pablo and Suisun bays. Pp.64-94 *in* D.W. Kelley, ed.: Ecological studies of the Sacramento-San Joaquin estuary, Part 1. Calif. Dept. Fish and Game, Fish Bulletin No. 133.

Goldman, C.R. and A.J. Horne 1983. Limnology. McGraw-Hill Book Company, New York, New York.

Herbold, B. 1994. Habitat requirements of delta smelt. Interagency Program Newsletter. Winter 1994: 1-3.

Messersmith, J.D. 1966. Fishes collected in Carquinez Straight in 1961-1962. Pages 57-62 *in*: D.W. Kelly, editor. Ecological Studies of the Sacramento-San Joaquin Estuary, Part 1. Calif. Dept. Fish and Game, Fisheries Bulletin 133

Monroe, M.W. and J. Kelly 1992. State of the estuary: A report on conditions and problems in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. San Francisco Estuary Project, Oakland, California.

Moyle, P.B. 1976. Inland Fishes of California. University of California Press. Berkeley, California. 405 pp.

Moyle, P. B., B. Herbold, D. E. Stevens, and L. W. Miller 1992. Life history and status of delta smelt in the Sacramento-San Joaquin Estuary, California. Trans. Am. Fish. Soc. 121:67-77.

Moyle, P.B. and R. M. Yoshiyama 1992. Fishes, aquatic diversity management areas, and endangered species: A plan to protect California's native aquatic biota. Draft report prepared for California Policy Seminar, University of California, Berkeley, California. July 1992. 196 pp.

Nichols, F.H., J.E. Cloern, S.N. Luoma, and D.H. Peterson 1986. The modification of an estuary. Science 231:567-573.

Radtke, L. D. 1966. Distribution of smelt, juvenile sturgeon, and starry flounder in the Sacramento-San Joaquin Delta. Pp. 115 - 119 in J. L. Turner and D. W Kelley, eds.: Ecological studies of the Sacramento-San Joaquin estuary, Part 2. California Department of Fish and Game Fish Bulletin No. 136.

Rutter, C. 1908. The fishes of the Sacramento-San Joaquin basin, with a study of their distribution and variation. Bulletin of U.S. Bureau of Fisheries 27(637) 103-152.

Sommer, T., R. Baxter and B. Herbold. In prep. The resilience of splittail in the Sacramento-San Joaquin Estuary. To be submitted to Transactions of the American Fisheries Society.

Swanson, C. and J. J. Cech, Jr. 1993. Environmental tolerances and requirements of the delta smelt, *Hypomesus transpacificus*. Final Report. 77 pp.

Sweetnam, D.A. and D.E. Stevens 1993. Report to the Fish and Game Commission: A status review of the delta smelt (*Hypomesus transpacificus*) in California. Candidate Species Status Report 93-DS. 98 pages plus appendices.

Turner, J.L. and D.W. Kelley 1966. Ecological studies of the Sacramento-San Joaquin Delta. Calif. Dept. Fish and Game Bull. 136.

Unger, P. 1994. Quantifying salinity habitat of estuarine species. IEP Newsletter. 1994: 7-10.

U.S. Fish and Wildlife Service 1993. Endangered and threatened wildlife and plants; Determination of threatened status for the delta smelt. March 5, 1993 Fed. Reg. 58(42):12854-12864.

U.S. Fish and Wildlife Service 1994a. Endangered and threatened wildlife and plants; Proposed determination of threatened status for the Sacramento splittail. January 6, 1994. Fed. Reg. 862-869.

U.S. Fish and Wildlife Service 1994b. Formal consultation on the 1994 operation of the Central Valley Project and State Water Project: Effects on delta smelt. 34 pages, plus figures.

U.S. Fish and Wildlife Service 1994c. Endangered and threatened wildlife and plants; Critical habitat determination for the delta smelt. December 19, 1994. Fed. Reg. 65256-65279.

U.S. Fish and Wildlife Service 1994d. Technical/Agency Draft Sacramento-San Joaquin Delta Native Fishes Recovery Plan. U.S. Fish and Wildlife Service, Portland, Oregon.

Wang, J.C.S. 1986. Fishes of the Sacramento-San Joaquin estuary and adjacent waters, California: A guide to the early life histories. Interagency Ecological Study Program for the Sacramento-San Joaquin Estuary. Tech. Rept. 9.

Wang, J.C.S. 1991. Early life stages and early life history of the delta smelt, *Hypomesus transpacificus*, in the Sacramento-San Joaquin estuary, with comparison of early life stages of the longfin smelt, *Spirinchus thaleichthys*. Interagency Ecological Studies Program for the Sacramento-San Joaquin Estuary. Tech. Rept. 28.

Weihs, D. 1974 Energetic advantages of burst swimming of fish. J. Theor. Bio. 48.215-229.

PERSONAL COMMUNICATIONS

Coulston, P., California Department of Fish and Game, IEP Program Manager, 4001 N. Wilson Way, Stockton, CA 95205-2424

Meng, L., U.S. Fish and Wildlife Service, Endangered Species Office, 2800 Cottage Way, Sacramento, California 95825

Moyle, P.B., University of California, Davis, Davis, California 95616.

Sweetnam, D., California Department of Fish and Game, Bay-Delta and Special Water Projects Division, 4001 N. Wilson Way, Stockton, CA 95205-2424.